Deccan Education Society's
Fergusson College (Autonomous), Pune-4
Department of Microbiology

Syllabi NEP 1.0 Implemented from Academic Year 2025-26
T.Y. BSc Semester : V/VI

Program Specific Outcomes (PSOs)

PSO	Outcomes
PSO1	Academic competence: (i) Understand fundamental concepts, principles and processes underlying the field of Microbiology, its different subfields and its linkage with related disciplinary areas/subjects. (ii) Demonstrate an understanding of a wide range of Microbiological techniques (e.g., basic microscopy, sterilization and disinfection methods, cultivation of microorganisms, isolation techniques, characterization of pathogens, blood grouping, microbiological assays of antibiotics and vitamins, enzyme kinetics, chromatography, electrophoresis, immunological assays.
PSO2	Personal and Professional Competence: (i) Carry out laboratory-orientated numerical calculations and be capable in data visualization and interpretation. (ii) Analyse biochemical data (e.g., in enzyme kinetics, biochemical analysis of serum components, sterility of pharmaceutical products). (iii) Formulate ideas, write scientific reports, and demonstrate effective presentation and communication skills.
PSO3	Research Competence: (i) Apply microbiological methodology in order to conduct research and demonstrate appropriate skill to seek solutions to problems that emerge in various fields of Microbiology and interdisciplinary fields. (ii) Integrate informatics and statistical skills to explore and authenticate biological data for experimental and research purposes. (iii) Exhibit awareness of ethical issues in research with emphasis on academic and research ethics, scientific misconduct, intellectual property rights and issues of plagiarism
PSO4	Entrepreneurial and Social competence: (i) Employ skills in specific areas related to Microbiology such as industrial production, technology development, clinical, health, agriculture and ensure multilevel commitment to health and human welfare.

T.Y. B. Sc. NEP 1.0						
Semester	Paper	Paper Code	Title	Type	Credits	Exam Type
V	Major	MIC-301	Medical Microbiology	Theory	2	CE+ESE
		MIC-302	DNA-Functioning & Transfer In Bacteria	Theory	2	CE+ESE
		MIC-303	Enzymology	Theory	2	CE+ESE
	Elective	MIC-304	Fundamentals of Immunology	Theory	2	CE+ESE
		OR				
		MIC-305	Fundamentals of Biostatistics and Bioinformatics	Theory	2	CE+ESE
		MIC-306	Principles of Fermentation Technology	Theory	2	CE+ESE
		OR				
		MIC-307	Epidemiological Principles and Experimental Analysis	Theory	2	CE+ESE
	Major	MIC-311	Microbiology Practical -5 (Based On Medical Microbiology and Biostatistics)	Practical	2	CE+ESE
		MIC-312	Microbiology Practical -6 (Based on Biochemistry)	Practical	2	CE+ESE
	VSC	MIC-331	Nanotechnology and AI in Microbiology	Theory	2	CE
		MIC-332	Microbiology Practical -7 (Based on Fermentation Technology and Nanotechnology)	Practical	2	CE
	Minor	MIC-321	Defense Systems against pathogens	Theory	2	CE+ESE
	FP	MIC-345	Field Project	Theory / Practical	2	CE

VI	Major	MIC-351	Immunological Processes	Theory	2	CE+ESE
		MIC-352	Metabolic Activities of Microorganisms	Theory	2	CE+ESE
		MIC-353	Large Scale Bioprocesses	Theory	2	CE+ESE
	Elective	MIC-354	Recombination & Gene Manipulation	Theory	2	CE+ESE
		OR				
		MIC-355	Cellular Communication in Bacteria	Theory	2	CE+ESE
		MIC-356	Antimicrobial Therapy and Prevention	Theory	2	CE+ESE
		OR				
		MIC-357	Food and Dairy Microbiology	Theory	2	CE+ESE
	Major	MIC-361	Microbiology Practical 8 (Based on Immunology)	Practical	2	CE+ESE
		MIC-362	Microbiology Practical - 9 (Based on Genetics and cellular communication)	Practical	2	CE+ESE
	VSC	MIC-382	Microbiology Practical -10 (Based on Large Scale Bioprocesses and Food and Dairy Microbiology)	Practical	2	CE
	Minor	MIC-371	Basics of Mycology& Virology	Theory	2	CE+ESE
	OJT	MIC-395	OJT	Theory / Practical	4	CE

T. Y. B. Sc. Semester V		
	MIC-301 - Medical Microbiology **Major** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe in details different human body systems, defense mechanisms associated with human body systems.	1
CO2	Give examples of pathogenic organisms affecting human body systems, Differentiate between different types of pathogenic organisms, and explain in details pathogenicity, diagnosis of pathogenic organisms.	2
CO3	Interpret the possible suggested preventive and treatment methods for human pathogens.	3
CO4	Classify pathogenic organisms based on their morphological and biochemical characteristics and distinguish between based on clinical samples from which pathogens can be isolated.	4
CO5	Compare different determinants of pathogenicity, Evaluate effect of these determinants on disease causation.	5
CO6	Write different resistance mechanisms of pathogens to human body system, Make comparative chart for types of toxins and its mode of action.	6

MIC-301 - Medical Microbiology
(Major- Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Physiology and anatomy of human body systems and defence mechanisms. Representative bacterial, fungal and viral infectious diseases of the systems (General and biochemical characters, diagnosis, prevention, treatment)** Skin: *Pseudomonas aeruginosa*, *Staphylococcus aureus*,**)** Respiratory system: *Mycobacterium, tuberculosis*, Influenza virus, Corona virus, Gastrointestinal tract: Hepatitis virus, *Entamoeba histolytica*, Central nervous system: *Clostridium tetani*, Polio virus, Urogenital system: *Treponema pallidum*, *Candida*, *HIV*	**15**
II	**Determinants of pathogenicity** A stepwise process in infection: Adhesion, Colonization, and invasion of host tissues with detailed accounts of virulence factors of pathogenic Organisms, Evasion mechanisms of pathogenic organisms Mechanisms of bacterial resistance to host cellular and humoral defences, Toxigenesis: Exotoxins, enterotoxins and endotoxins, role in pathogenicity, PIAs and its role in bacterial virulence	**15**

Learning Resources- References

Sr. No.	References
1.	Tortora, G.J., Funke, B.R., Case, C.L, 2016. MIC-robiology: An introduction. 12th Edition, Benjamin Pub. Co. NY.
2.	Indira T. Kudva, Nancy A. Cornick, Paul J. Plummer, Qijing Zhang, Tracy L. Nicholson, John P. Bannantine, Bryan H. Bellair 2016. Virulence mechanisms of bacterial pathogens. 5th edition. SBN: 978-1-555-81927-9.
3.	Ananthnarayan, R. and C.E, Jayaram Panikar, 2020. Ananthnarayan and Panikar's Textbook of MIC-robiology, 10th edition, Universities Press.
4.	Cruickshank K.R., 2005, Medical MIC-robiology Vol I & II Livingstone, Longman. (Topic II AND IV)
5.	Chakraborty P. 2009, Textbook of Medical Parasitology, Central Publications, Kolkata, India

	MIC-302 - DNA Functioning & Transfer In Bacteria **Major** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall and define the fundamental concepts and processes involved in DNA replication, transcription, and translation in prokaryotes and eukaryotes.	1
CO2	Explain the mechanisms of DNA replication, transcription, and translation, highlighting the similarities and differences between prokaryotes and eukaryotes.	2
CO3	Apply the knowledge of gene transfer mechanisms to map bacterial chromosomes and understand the implications for bacterial evolution.	3
CO4	Analyze the impact of different DNA damage types on genetic material and compare the mechanisms of DNA repair.	4
CO5	Evaluate the efficiency and significance of DNA repair mechanisms in maintaining cellular genome stability.	5
CO6	Design experiments to investigate bacterial gene transfer processes and DNA repair mechanisms, employing techniques like conjugation, transformation, and co-transduction.	6

MIC- 302 - DNA Functioning & Transfer In Bacteria
(Major- Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Central Dogma, DNA damage and repair:** a. DNA replication – Overview of prokaryotic DNA replication, Eukaryotic DNA replication, multiple replicons, pre-priming & priming eukaryotic DNA polymerases, ARS in yeast, origin recognition complex (ORC), Regulation of replication b. Prokaryotic Transcription – Structure of promoter, Structure and role of RNA polymerases, Initiation, elongation and termination, Concept of operon – Lac operon c. Prokaryotic Translation - Structure & role of mRNA, tRNA and ribosomes in translation, Activation of tRNA, Initiation, elongation, translocation and termination of translation d. DNA damage by hydrolysis, deamination, alkylation, oxidation and radiation e. DNA repair mechanisms – Mismatch repair, Nucleotide excision repair, Photoreactivation, SOS response	**15**
II	**Gene Transfer in bacteria:** a. Transformation- Development of competence in Gram positive and Gram negative bacteria, Process of transformation in Gram positive and Gram negative bacteria, Factors affecting transformation, Mapping of chromosome by co-transformation b. Conjugation- Properties of F plasmid, F^+, F^-, Hfr and F' strains, Process of conjugation between F^+ and F^- and Hfr and F^-, Interrupted mating experiment. c. Transduction- Process of generalized transduction, Process of specialized transduction, Mapping by co-transduction.	**15**

Learning Resources- References

Sr. No.	References
1	Pierce, Benjamin A. Genetics: A Conceptual Approach. New York: W.H.Freeman,2012.
2	Strickberger, M. W., 1985 Genetics, 3rd edition Macmillan Pub. Co. NY.
3	Stanier, R. Y., 1985, General MIC-robiology, 4th edition and 5th edition, MacMillan Pub.Co. NY.
4	Hayes, William, 1984, The Genetics of Bacterial and their Viruses, CBS Pub, New Delhi.
5	Peter J. Russell, iGenetics: A Molecular Approach, 3rd edition, Pearson
6	Lewin Benjamin, 1994, Genes II, VII and VIII, Oxford University Press.

	MIC-303 - Enzymology **Major** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	List micronutrients required for cellular activities and their correlate their biochemical activity and deficiency disorders.	1
CO2	Discuss the use of various methods used for determination of protein structure and function	2
CO3	Outline from a variety of protein purification methods the correct procedures in order to purify a single protein/enzyme based on its properties and compare the use of these methods for lab level and large- scale purification of proteins.	3
CO4	Explain the effect of enzyme inhibitors on the kinetic parameters of anenzyme catalyzed reaction and differentiate between enzyme inhibitors based on graphical representation.	4
CO5	Compare between enzyme regulatory mechanisms used by prokaryotic and eukaryotic systems and evaluate the importance of these mechanisms.	5
CO6	Combine a variety of purification methods to achieve maximum purity and yield of a single protein.	6

MIC-303 – Enzymology
(Major- Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**A. Modern methods to determine amino acid composition at active site**: NMR spectroscopy XRD, and basic concept of Protein sequencing **B. Enzyme cofactors**: BiocheMIC-al function of water soluble and fat soluble vitamins in central energy yielding and biosynthetic pathways: Pyridine and flavin nucleotides, Vit B6, Vit A and Vit D **C. Methods / Techniques in Enzymology** A. Enzyme Assays, calculation of enzyme activity, specific activity and fold purification based on the principles of: Spectrophotometric methods, CoupledEnzyme assays (Luminescence based assays) B. Principles and methods of Enzyme purification: Methods of cell fractionation, Methods of Enzyme concentration: Ultrafiltration, Dialysis, Salt and solvent precipitation, Methods of Enzyme purification: Principle, Materials used and Applications: Based on differences in molecular size (Gel filtration), Based on differences in charged properties (Ion exchange Chromatography, Gel Electrophoresis)Based on differences in solubility (Isoelectric focusing and Isoelectric Precipitation)Based on differences in ligand affinity and selective adsorption (Metal affinity Ligand chromatography) Characterization of enzymes using Criteria of purity: Sedimentation analysis, concept of purity check using 2D	**15**

	electrophoresis.	
II	**A.** Regulation of Enzyme activity: Concept of Enzyme compartmentation at Cellular level Feedback Inhibition with examples from amino acid biosynthesis, Feedback Repression with example of Tryptophan operon, Allosteric enzymes, Isoenzymes Covalently modified regulatory enzymes **B.** Enzyme Kinetics: Concept of Initial velocity Michaelis Menten Equation for the initial velocity of single substrate enzyme catalyzed reaction, Briggs and Haldane modification of the Michaelis, Menten Equation for the initial velocity of single substrate enzyme catalyzed reaction. Michaelis Menten plot, Significance of kinetic constants Plotting Kinetic data using transformations of MM plot Lineweaver Burke plot, Hanes plot, Eadie Hofstee plot Eisenthal Cornish Bowden plot Concept, Types of enzyme inhibitions and Derivation of the Michaelis Menten Equation for the initial velocity of single substrate enzyme catalyzed reaction in the presence of the inhibitors, LB plots and Secondary plots for Enzyme catalyzed reactions in the presence of Enzyme inhibitors	**15**

Learning Resources- References

Sr. No.	References
1	Nelson D. L. and Cox M. M. (2017). Lehninger's Principles of Biochemistry 7thEdition, WH Freeman Macmillan Worth Pub. Co., New Delhi.
2	Segel Irvin H. (2010). Biochemical Calculations. 2nd edition, John Wiley and Sons, New York.
3	Garrett, R. H. and Grisham, C. M. (2009) Biochemistry. 4th Edition, Brooks / Cole, Publishing Company, California.
4	Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (2006) Outlines of Biochemistry 5th edition, John Wiley and Sons, New Delhi.
5	Palmer Trevor (2008). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry 2nd Edition, Horwood Pub. Co., Chinchester, England.
6	White David (200 6) Physiology and Biochemistry of Prokaryotes. 3rd Edition. Oxford University Press, New York.
7	Harvey Lodish et. al (2016), Molecular Cell Biology 8th Edition W. H. Freeman Macmillan Worth Pub. Co., New Delhi.

	MIC-304 - Fundamentals of Immunology **Elective** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe and classify isotypes of antibodies on the basis of their structure and biological properties and explain the molecular basis of their diversity.	1
CO2	Articulate concepts of defense mechanisms of human body, types of immunity and different cells and organs involved in combating pathogens.	2
CO3	Demonstrate different types of antigen-antibody interactions and their application in diagnosing different infections.	3
CO4	Differentiate types of antigens and explain their destruction by different types of immune cells.	4
CO5	Compare polyclonal and monoclonal response of immune system against antigen.	5
CO6	Design an experimental protocol to produce monoclonal antibodies and study their applications.	6

MIC-304 - Fundamentals of Immunology
(Elective- Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Overview of Immune system** **Three lines of defense mechanisms**: physical chemical and biological barriers **Types of immunity**: active and passive, specific and non- specific, Humoral and cell mediated **Cells and organs of the immune system:** Haematopoiesis and its kinetics: Formation of myeloid and lymphoid cell lineages, Lymphatic system Primary lymphoid organs: Thymus and Bursa Secondary lymphoid organs: Spleen, Lymph nodes, lymphoid tissues Concept of monoclonal antibodies: hybridoma technology and applications of monoclonal antibodies	**15**
II	**Antigens and Immunoglobulins Antigens:** Concept, Factors affecting immunogenicity, Antigenic epitope and paratope, Haptens and Adjuvants Types of antigens: thymus dependent and thymus independent, Autoantigens, super antigens, Iso-antigens MHC antigens, MHC gene locus in mouse and man Structure and functions of MHC Class-I and class- II Molecules, Antigen Processing and presentation: MHC class I and class II restriction pathway **Immunoglobulins:** Structure of basic unit, chemical and biological properties Classification into isotypes, Antigenic nature of immunoglobulins Molecular basis of antibody diversity:light chain diversity and heavy chain diversity	**15**

Learning Resources- References

Sr. No.	References
1	Janeway Charles A., Paul Travers, Mark Walport, Mark Shlomchik. Immunobiology Interactive, 2005. Garland Science Publishing, USA.
2	Kindt T. J., Goldsby R. A., Osborne B. A., 2007, Kuby Immunology 6th edition, W. H. Freeman and Co., New York.
3	Pathak S. S. and Palan V. (1997). Immunology - Essential and Fundamental, Pareen Publications, Bombay.
4	Roitt Evan, Brostoff J. Male D. (1993). Immunology 6th edition, Mosby and Co., London.
5	Roitt I. M. (1988). Essentials of Immunology, ELBS, London
6	Roitt M. (1984). Essentials of Immunology, P. G. Publishers Pvt. Ltd., New Delhi.

	MIC-305 - Fundamentals of Biostatistics and Bioinformatics **Elective** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Define key biostatistical terms, such as biostatistics, variables, population, sample, precision, and accuracy. Define key bioinformatics concepts such as databases, sequence alignment, and phylogenetic trees. Enlist the different databases used in Bioinformatics.	1
CO2	Describe different types of sampling techniques (random, stratified, systematic, convenience) and their applications in research. Differentiate between precision and accuracy in statistical measurements. Explain the principles behind sequence alignment, including global and local alignment. Describe the differences between pairwise sequence alignment tools (FASTA, BLAST) and their applications.	2
CO3	Apply various biostatistical techniques (e.g., calculating mean, median, mode, variance, and standard deviation) to real-life biological or health data. Apply tools such as FASTA, BLAST, and ClustalW to perform sequence alignment and analyze biological sequences.	3
4CO4	Analyze the distribution of data using measures of central tendency and dispersion. Analyze experimental data using tables and graphs. Compare different sequence alignment tools (e.g., FASTA vs. BLAST) and evaluate their performance in various biological contexts.	4
CO5	Evaluate the quality of data collected and decide on the appropriate statistical methods for analysis. Determine the precision and accuracy of the given data set. Assess the effectiveness of different alignment methods (global vs. local) and databasesfor specific types of bioinformatics research.	5
CO6	Create effective data visualizations (graphs and tables) to present research findings clearly. Design and implement a bioinformatics workflow that includes data retrieval,sequence alignment, and phylogenetic tree construction to answer specific biological questions.	6

MIC-305 - Fundamentals of Biostatistics and Bioinformatics
(Elective- Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to Biostatistics** 1) Introduction to Biostatistics: definition, importance, and role in life sciences, tools of data collection and analysis. 2) Variable definition, types and levels of measurement, concept of Precision and Accuracy 3) Population and sample. - Sampling technique and types of samples 4) Measures of central tendency: Mean, Mode, Median 5) Measures of dispersion: Variance and Standard deviation 6) Data summarization using tables 7) Data summarization using graphs	**15**
II	**Introduction to Bioinformatics** 1) Definition and Applications of Bioinformatics	**15**

	2) Databases used in Bioinformatics – types and uses 3) Sequence Alignment – Global and Local 4) Pairwise sequence alignment - FASTA and BLAST, Types of BLAST 5) Multiple sequence alignment – Clustal W 6) Phylogenetic trees – an introduction	

Learning Resources- References

Sr. No.	References
1	Khan and Khanum, Shiba Khan (2024). Fundamentals of Biostatistics. Ukaaz Publications, Hyderabad.
2	Ignacimuthu, S (2005). Basic bioinformatics. Harrow, Middlesex, U.K. : Alpha Science International
3	Supratim Choudhari (2014). Bioinformatics for Beginners – Genes, Genomes, Molecular Evolution, Databases and Analytical Tools AcadeMIC- Press

	MIC-306 - Principles of Fermentation Technology **Elective** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe a large number of substrates that are used for the industrial fermentation process.	1
CO2	Explain different types of reactors or fermenters which are used for laboratory, pilot and industrial scale fermentation and their process parameters.	2
CO3	Illustrate the detailed knowledge of the quality control procedures and how to apply them at industrial scale, the principles of IPR and their application in fermentation industry.	3
CO4	Analyse the given pharmaceutical product for its sterility, MIC-robiological assay procedures to determine the potency of the products like antibiotics and vitamins	4
CO5	Evaluate the quality of fermentation products by carrying out the test for sterility, carcinogenicity, pyrogenicity, toxicity and shelf life of the product.	5
CO6	Synthesize different products with the upstream and several downstream processes carried out in fermentation industry	6

MIC-306 - Principles of Fermentation Technology
(Elective- Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Media optimization** Classical Approach-one factor at a time. Full factorial design Plackett Burman Design, Response surface methodology (RSM) **Scale up and scale down** Objective of scale up, Levels of fermentation (Laboratory, pilot plant and production levels), Scale down **Principles and methods of downstream processing** Cell Disruption, Filtration, Centrifugation, Liquid liquid extraction Distillation, Ion exchange chromatography, Drying.	**15**
II	**Fermentation economics** Contribution of various expense heads to a process (Recurring and non-recurring expenditure) citing any suitable example **Quality Assurance of fermentation product:** Detection and quantification of the product by physicocheMIC-al, biological and enzymatic methods, Sterility testing Pyrogen testing- Endotoxin detection**,** Ames test and modified Ames test, Toxicity testing vi. shelf life determination **Introduction to intellectual property rights** Patents, Trade mark**,** Copy right, Indian patent act	**15**

Learning Resources- References

Sr. No.	References
1	Casida, L. E., 1984, Industrial MIC-robiology, Wiley Easterbs, New Delhi
2	Peppler, H. L 1979, MIC-robial Technology, Vol I and II, AcadeMIC- Press.
3	Stanbury, P. F. and Whittaker, A. (1984) Prionciples of Fermentation technology, Pergamon press
4	Prescott. S.C and Dunn, C. G., 1983 Industrial MIC-robiology, Reed G. AVI tech books.
5	H. Patel. (1985), Industrial MIC-robiologu, Macmillan India Ltd
6	Indian Pharmacopia and British Pharmacopia (Latest Edn).

	MIC-307 - Epidemiological Principles and Experimental Analysis **Elective** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Define key biostatistical terms, such as biostatistics, variables, population, sample, precision, and accuracy. Define key bioinformatics concepts such as databases, sequence alignment, and phylogenetic trees. Enlist the different databases used in Bioinformatics.	1
CO2	Describe different types of sampling techniques (random, stratified, systematic, convenience) and their applications in research. Differentiate between precision and accuracy in statistical measurements. Explain the principles behind sequence alignment, including global and local alignment. Describe the differences between pairwise sequence alignment tools (FASTA, BLAST) and their applications.	2
CO3	Apply various biostatistical techniques (e.g., calculating mean, median, mode, variance, and standard deviation) to real-life biological or health data. Apply tools such as FASTA, BLAST, and ClustalW to perform sequence alignment and analyze biological sequences.	3
CO4	Analyze the distribution of data using measures of central tendency and dispersion. Analyze experimental data using tables and graphs. Compare different sequence alignment tools (e.g., FASTA vs. BLAST) and evaluate their performance in various biological contexts.	4
CO5	Evaluate the quality of data collected and decide on the appropriate statistical methods for analysis. Determine the precision and accuracy of the given data set. Assess the effectiveness of different alignment methods (global vs. local) and databasesfor specific types of bioinformatics research.	5
CO6	Create effective data visualizations (graphs and tables) to present research findings clearly. Design and implement a bioinformatics workflow that includes data retrieval,sequence alignment, and phylogenetic tree construction to answer specific biological questions.	6

MIC-307 - Epidemiological Principles and Experimental Analysis
(Elective- Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Epidemiological principles** Definition, scope and applications, Incidence and prevalence rates, mortality and morbidity rates, Disease distribution based on time, place and person, Types of epidemiological methods Descriptive epidemiology, Analytical epidemiology Experimental epidemiology Case control and cohort studies – study design and application Epidemiology of infectious diseases, Sources and reservoirs of infection, Modes of transmission of infections, Prevention and treatment measures, Emerging infectious diseases.	**15**
II	**A) Experimental epidemiology** Randomized controlled trials: Types of Randomized controlled trials**:** Clinical trials, Preventive	**15**

	trials, risk factor trials, cessation experiments, Trial of etiological agents, Evaluation of health services Nonrandomized controlled trials: Types of non- Randomized controlled trials: Uncontrolled trials, Natural experiments, Before and after comparison studies Concept of association and causation **B) Epidemiological survey** Development of hypothesis, Data collection and organization Statistical analysis, Graphical representation using computers and its interpretation, Preparation of report	

Learning Resources- References

Sr. No.	References
1.	Park and Park, Preventive and Social medicine. 2013, Publisher: Banarsidas Bhanot, Jabalpur.

	MIC-311 - Microbiology Practical -5 **Major** **Practical**	
	Number of Credits: 02 **No. of Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Identify the pathogenic organisms associated with clinical samples	1
CO2	Conclude the observations of urine analysis with respect to body disorder such as diabetes, kidney malfunctioning etc.	2
CO3	Carry out physical, chemical, and microscopic tests of the urine sample	3
CO4	Classify human pathogens into different groups based on morphological and biochemical tests.	4
CO5	Determine sensitivity of pathogenic organisms to various antimicrobials	5
CO6	Write differences in the growth characteristics of pathogens on different media	6

MIC-311-Microbiology Practical -5
(Major- Practical)

Unit No.	Title of Unit and Contents	No. of Lectures
I	a) Physical and microscopic examination of clinical sample - urine b) Chemical analysis of urine sample c) Isolation, Identification of pathogens from urine sample d) Isolation, Identification of pathogens from stool sample e) Isolation, Identification of pathogens from pus sample f) Biochemical characterization of the isolates using identification keys as well as Bergey's Manual	**5**
II	a) Antibiotic sensitivity testing of Gram-positive isolates b) Antibiotic sensitivity testing of Gram-negative isolates c) Study of growth characteristics of human pathogens on selective media- Cetrimide agar, Tetrathionate broth, Selenite F d) Study of growth characteristics of human pathogens on differential media- SS agar, MSA e) Basic statistical analysis of any clinical data using Excel	**5**

Learning Resources- References

Sr. No.	References
1	Cruckshank R and J.P. Duguid (1980) Medical Microbiology Volume II, 12th Edition.The Practice of Medical Microbiology, Churchill Livingstone Edinburgh, London and New York
2	Dubey, R.C. and Maheshwari, D. K. (2002). Practical Microbiology. S Chand and Company Pvt Ltd.
3	Mukherjee K.L. Medical Laboratory Technology – A practical Manual for routine diagnostic tests – Volume I to Volume III. Tata Mac Graw Hill Company.

	MIC-312 - Microbiology Practical -6 **Major** **Practical**	
	Number of Credits: 02 **No. of Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall the laws pertaining to transmission and absorbance and their mathematical expression and correlate these to determination of absorption maxima and molar absorptivity	1
CO2	Extrapolate data to quantify samples by preparing standard dose responses made using quantitative biochemical estimation methods.	2
CO3	Examine quantitative enzyme assays for degradative extracellular enzymes such as Amylase	3
CO4	Detect the presence of amino acids and sugars using paper chromatography by resolving mixtures	4
CO5	Assess the use of neutral bivalent salts to concentrate proteins from natural samples	5
CO6	Formulate a combination of chemicals to produce a buffer of desirable pH, strength and quantity	6

MIC-312 - Microbiology Practical -6
(Major- Practical)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**a)** Determination of ƛ max of biological compounds **b)** Determination of Molar Extinction coefficient of biological compounds **c)** Preparation of Buffers: Calculations using the Hendersen-Hasselbach Equation **d)** Paper Chromatography of sugars: Resolution of mixture use of locating agents Iodine, Methanolic H_2SO_4 **e)** Paper Chromatography of amino acids: Resolution of mixture using locating agent Ninhydrin **f)** Thin layer chromatography of biomolecules	**5**
II	a) Preparation of SDR for reducing sugars using DNS protocol b) Preparation of SDR for total carbohydrate content using Anthrone/ Phenol sulphuric acid protocol c) Preparation of SDR for proteins using Folin Lowry protocol d) Screening and Isolation of Amylase producers from soil samples e) Amylase concentration using salt/solvent precipitation f) Amylase assay and establishment of purification chart	**5**

Learning Resources- References

Sr. No.	References
1	An Introduction to practical biochemistry (2nd edition) David T. Plummer. McGraw- Hill Book Company (U.K.) Ltd., London 1978.
2	Principles and Techniques of Practical Biochemistry (6th Ed.), Wilson, K., Walker, J. (eds.); Cambridge University Press, Cambridge, 2000,
3	Biochemical calculations: how to solve mathematical problems in general biochemistry, Irwin H Segel, Wiley,1976.
4	Trinder P. Annals. Clin. Biochem. 6, 24 (1969)
5	Bergmayer, HV., "Methods of Enzymatic Analysis", A.P.N.Y. (1974). Page 1196.
6	M. Dashora, Proceeding of XIII Annual Conf. ACNI, page 17.
7	Dumas, B.T.et al, Clin. Chem. Acta, 31,87(1971).
8	Young, D.S. et al.21, D (1975)
9	Sadasivam, S. and Manickam, A. (2005) Biochemical methods. 2nd Edition, New age International, New Delhi.
10	Laboratory manual in biochemistry, J Jayaraman, Wiley Eastern, 1981.

	MIC-331 - Nanotechnology and AI in Microbiology **VSC** **Practical**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Demonstrate knowledge of bio-nanotechnology fundamentals and AI/ML applications in Microbiology.	1
CO2	Analyze the properties and synthesis methods of nanomaterials and apply ML algorithms to microbiological data analysis.	2
CO3	Discuss the applications of bio-nanotechnology and utilize AI/DL techniques for microbiological data interpretation.	3
CO4	Design and develop nanomaterials for specific applications and apply natural language processing techniques for microbiological literature analysis.	4
5CO5	Evaluate the risks and benefits of nanomaterials and utilize ML/DL models for predicting antimicrobial resistance.	5
6CO6	Critically assess the current state and future directions of bio-nanotechnology and AI in Microbiology.	6

MIC-331 - Nanotechnology and AI in Microbiology
(VSC- Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Bio-nanotechnology** **Introduction to Bionanotechnology** Definition and Scope, Interdisciplinary Nature, Biological Inspiration, Types and properties Nanomaterials (metallic, polymeric, and organic). **Synthesis of Nanomaterials** **Biological Methods:** Role of Microorganisms, plants, and biomolecules in nanoparticle synthesis. **Chemical and Physical Methods:** Comparison with biological synthesis. **Applications of Bionanotechnology** **Healthcare and Medicine:** Drug delivery systems, imaging, diagnostics, and biosensors. **Environmental Applications:** Energy, Wastewater treatment, biosensors for pollution detection, and bioremediation. **Agricultural Applications:** Nano fertilizers and Nano pesticides. **Industrial Applications:** Food technology, cosmetics, and textiles	**15**
II	**Artificial Intelligence (AI) in Microbiology** Introduction, Types of AI (narrow, general, and superintelligence) and Machine Learning (ML), (Supervised and unsupervised learning), Regression, classification, and clustering, Deep Learning (DL) (Neural networks, convolutional neural networks and recurrent neural networks) Natural Language Processing (text mining, sentiment analysis, and topic modeling) **Applications of AI, ML and DL in Microbiology**	**15**

	a. Artificial Intelligence (AI): Microbial Diagnostics, Microbial Therapeutics b. Machine Learning (ML): species identification, antimicrobial resistance prediction and Microbial community analysis c. Deep Learning (DL): image analysis, genomic analysis, and transcriptomic analysis d. Natural language processing (literature mining, clinical text analysis, and microbial genome annotation)	

Learning Resources- References

Sr. No.	References
1	Christof M. Niemeyer and Chad A. Mirkin (2006). Nanobiotechnology, John Wiley & Sons.
2	Daniel L. Feldheim and Colby A. Foss, Jr. (2002). Metal Nanoparticles Synthesis, Characterization and Applications, Marcel Dekker, Inc.
3	Mahendra Rai and Nelson Duran (2011). Metal Nanoparticles in the MIC-robiology, Springer Verlag Berlin Heidelberg.
4	Topol, E. J. (2019). High-performance medicine: The convergence of human and artificial intelligence. Nature Medicine, 25(1), 44–56.
5	LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. Nature, 521(7553), 436–444.
6	Miner, G., et al. (2012). Practical text mining and statistical analysis for non- structured text data applications. AcadeMIC- Press.
7	Yang, J., et al. (2020). Predicting antiMIC-robial resistance in MIC-robial pathogens using machine learning. Clinical MIC-robiology and Infection, 26(1), 11–19.
8	Rodríguez-González, A., et al. (2022). AntiMIC-robial resistance prediction using supervised machine learning and genoMIC- data. Scientific Reports, 12(1), 1009.
9	Russell, S. J., & Norvig, P. (2020). Artificial Intelligence: A Modern Approach. Pearson Education.
10	Kaul, A., et al. (2021). The future of artificial intelligence in MIC-robiology. Frontiers in MIC-robiology, 12, 642756.
11	Dousa, M., et al. (2023). Ethical implications of AI in MIC-robiology: Balancing innovation and responsibility. AI & Society, 38, 237–248.

	MIC-332 - Microbiology Practical-7 **VSC** **Practical**	
	Number of Credits: 02 **No. of Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Outline basic knowledge of isolation of different types of lactic acid bacteria from the curd samples.	1
CO2	Discuss the effect on spoilage causing bacteria by testing the antifungal activity of the lactic cultures.	2
CO3	Calculate minimal inhibitory concentration and minimal bactericidal concentration to the standard antibiotic streptomycin.	3
CO4	Analyze the potency of antibiotics and vitamins using bioassay technique. Test the antifungal activity of these lactic cultures and understanding its effect on spoilage causing bacteria.	4
CO5	Evaluate the quality of pharmaceutical products like surgical cotton and water for injection	5
CO6	Synthesize ethanol using Saccharomyces cerevisiae cultivated in jaggery medium	6

MIC-332 - Microbiology Practical-7
(VSC- Practical)

Unit No.	Title of Unit and Contents	No. of Lectures
I	a) Isolation and identification of Lactic culture up to genus level. b) Antifungal activity of Lactic acid bacteria. c) Screening and isolation of pesticide degraders from soil. d) Isolation and identification of Aspergillus sp. From onions infected with black mold. e) Isolation and identification of *Xanthomonas* sp from infected sample. f) Biosynthesis of silver nanoparticles	**5**
II	a) MIC- and MBC of antibacterial compounds b) Microbiological assay of antibiotic (agar gel diffusion technique) c) Microbiological assay of Cyanocobalamin (agar gel diffusion technique d) Sterility testing of pharmaceutical products by direct inoculation method. e) Sterility testing of pharmaceutical product by membrane filtration method f) Visit to a Dairy/ Fermentation industry/Agriculture college and preparation of visit report	**5**

Learning Resources- References

Sr. No.	References
1	Casida, L. E., 1984, Industrial Microbiology, Wiley Easterbs, New Delhi
2	Peppler, H. L 1979, Microbial Technology, Vol I and II, Academic- Press.
3	Indian Pharmacopeia and British Pharmacopeia (Latest Edn).

	MIC-321- Defense Systems against pathogens **Minor** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall and define basic concepts of immunity, including the three lines of defense mechanisms (active, passive, specific, and non-specific immunity), and the cells and organs involved in immune responses.	1
CO2	Explain the processes of hematopoiesis, differentiation of immune cells, and the structure and function of primary and secondary lymphoid organs.	2
CO3	Apply their understanding of immunological processes such as phagocytosis, inflammation, and the complement system to describe how the body responds to infection.	3
CO4	Analyze the factors affecting immunogenicity and specificity, as well as the structure and function of antigenic determinants and immunoglobulins.	4
CO5	Evaluate the significance of thymus and bone marrow in the development of functional immune cells.	5
CO6	Recall and define basic concepts of immunity, including the three lines of defense mechanisms (active, passive, specific, and non-specific immunity), and the cells and organs involved in immune responses.	6

MIC-321 - Defense Systems against pathogens
(Minor- Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Introduction to Immunology** Immunity definition and three lines of defense mechanisms: active, passive immunity, specific and non-specific immunity Cells and organs of immune system Hematopoiesis: Erythrocytic, myelocytic, monocytic and lymphocytic lineages and differentiation process, lymphocyte types and subsets Primary lymphoid organs (Thymus and Bursa): Thymus - structure, thymic education (positive and negative selection). Secondary lymphoid organs: Structure and function of spleen and lymph node, mucous associated lymphoid tissuei	**15**
II	**Antigen and Immunoglobulins** Antigen Concepts and factors affecting immunogenicity and basis for specificity Antigenic determinants, haptens and cross- reactivity, Carriers Adjuvant: conventional and novel MHC antigens Immunoglobulin Structure of basic Unit, chemical and biological properties, Isotypes of immunoglobulins Humoral immune response and Cell-mediated immune response Immunological processes: Phagocytosis, inflammation, complement system	**15**

Learning Resources- References

Sr. No.	References
1	Janeway Charles A., Paul Travers, Mark Walport, Mark Shlomchik. Immunobiology Interactive, 2005. Garland Science Publishing, USA.
2	Kindt T. J., Goldsby R. A., Osborne B. A., 2007, Kuby Immunology 6th edition, W. H. Freeman and Co., New York.
3	Pathak S. S. and Palan V. (1997). Immunology - Essential and Fundamental, Pareen Publications, Bombay.
4	Roitt Evan, Brostoff J. Male D. (1993). Immunology 6th edition, Mosby and Co., London.
5	Roitt I. M. (1988). Essentials of Immunology, ELBS, London.
6	Roitt M. (1984). Essentials of Immunology, P. G. Publishers Pvt. Ltd., New Delhi

	MIC-345 – Field Project (FP) **Major** **Theory/Practical**	
	Number of Credits: 02 **No. of Hours: 60**	

T. Y. B.Sc. Semester VI		
	MIC-351 - Immunological Processes **Major** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe different types of mechanisms in the activation of innate immune response	1
CO2	Classify and compare major histocompatibility complex molecules and their role in transplantation of grafts	2
CO3	Demonstrate and classify hypersensitivity reactions and outline their mechanisms	3
CO4	Explain and identify the role of immunological mediators in innate immune response and cell-cell interactions	4
CO5	Compare the role of cytokines and categorize them according to their function in cell mediated immune response	5
CO6	Specify and analyze the pathways of antigen processing and presentation	6

MIC-351 - Immunological Processes
(Major-Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Regulation and activation of immune response Cytokines:** Types, General characters and role in immune activation - Interferons, Interleukins and TNFs **Non-specific defence mechanisms**: **Humoral components:** Defensins, pattern recognition proteins (PRP) and pathogen associated molecular patterns (PAMPs), kinins, acute phase reactants **Phagocytosis** (oxygen dependent and independent systems) **Complement** and its activation (Classical, Alternative and lectin pathway), Coagulation system **Inflammation** (cardinal signs, mediators, vascular and cellular change, toll like receptors **Cell mediated Immune response:** Activation and differentiation of T cells, Mechanism of CTL mediated cytotoxicity, ADCC	**15**
II	**Clinical and diagnostic Immunology Antigen-Antibody interactions** Concept of antibody avidity, affinity and cross-reactivity, Precipitation reactions, Agglutination reactions, Immunofluorescence, ELISA and its modifications **Transplantation:** Types of Grafts, Allograft rejection mechanisms, Prevention of allograft rejection; Immunosuppression, HLA typing **Hypersensitivity**: Immediate and delayed type of hypersensitivity, Gell and Coombs classification of hypersensitivity, mechanism with examples for type I, II, III and IV **Autoimmunity**: Types, Immunopathological mechanisms, Theories of origin of autoimmunity, Pathophysiology (mechanism of symptom generation) of Myasthenia gravis and Rheumatoid arthritis, Therapeutic immunosuppression for autoimmunity	**15**

Learning Resources- References

Sr. No.	References
1	Janeway Charles A., Paul Travers, Mark Walport, Mark Shlomchik. Immunobiology Interactive, 2005. Garland Science Publishing, USA.
2	Kindt T. J., Goldsby R. A., Osborne B. A., 2007, Kuby Immunology 6th edition, W. H. Freeman and Co., New York.
3	Pathak S. S. and Palan V. (1997). Immunology - Essential and Fundamental, Pareen Publications, Bombay.
4	Roitt Evan, Brostoff J. Male D. (1993). Immunology 6th edition, Mosby and Co., London.
5	Roitt I. M. (1988). Essentials of Immunology, ELBS, London.
6	Roitt M. (1984). Essentials of Immunology, P. G. Publishers Pvt. Ltd., New Delhi.

	MIC-352 - Metabolic Activities of Microorganisms **Major** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall key bio catalytic agents involved in the biochemical synthesis and degradation of biomolecules in microbial systems and focus on their regulatory significance	1
CO2	Outline the composition of biological membranes to their structure and function differentiating cellular and subcellular systems on the diversity of membrane components	2
CO3	Calculate the energy requirements or energy output of biochemical pathways and grade these pathways for their use and indispensability	3
CO4	Analyse the free energy change occurring during the progress of a biochemical reaction and correlate it to the feasibility of the reaction in biological systems	4
CO5	Compare the use of multiple transport processes and their use under differing cellular conditions	5
CO6	Specify the use of certain groups of high energy compounds as common currency used by cellular systems	6

MIC-352 - Metabolic activities of Microorganisms
(Major-Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**A. Role of Membrane structure and function in metabolism** Membrane Structure and Specificity Concept of polar and nonpolar biomolecules transported across biological membranes, Membrane potential and its significance Structure of lipid bilayer and the Fluid Mosaic model with components: Glycerophospholipids, Sterols and Proteins Differences in membranes of subcellular compartments and the plasma membranes of microbial, animal and plant cells. Membrane Transport: Revise concepts of mathematical expressions and examples for Diffusion, Osmosis, Passive Transport, active transport and facilitated transport, Primary active transport with examples, Secondary active Transport with examples, Examples for multiple transport mechanisms for a single solute: Group translocation, Sodium Glucose symporter and GLUTS **Bioenergetics** Revision of Fundamentals Concepts Laws of Thermodynamics free energy considerations in biological systems, Concept of enthalpy, entropy and free energy, activation energy, feasibility of reactions, coupled reactions High energy compounds amongst high energy compounds, Common high energy compounds used in biological systems: Reasoning, structure and utilization. Pyrophosphates, enolic phosphates, Thioesters Energy conservation	**15**

II	Biosynthesis and Degradation of Biomolecules through metabolic pathways Biosynthesis: Concept of polymerization Polysaccharides: Starch, Glycogen and Peptidoglycan Lipids: Fatty acids, Triacylglycerols and phospholipids Degradation of Macromolecules Polysaccharides: Starch, Cellulose and Glycogen, Lipids: Beta Oxidation of fatty acids, Protein Urea cycle Photosynthesis in Bacteria Concept of bacterial photosynthesis: Habitats and examples of photosynthetic bacteria, Photosynthetic apparatus, Oxygenic and anoxygenic mechanisms, Synthesis of reserve food material through photosynthesis, Cyclic and Non-cyclic photophosphorylation and conservation of energy	**15**

Learning Resources- References

Sr. No.	References
1	Nelson D. L. and Cox M. M. (2017). Lehninger's Principles of Biochemistry 7th Edition, WH Freeman Macmillan Worth Pub. Co., New Delhi.
2	Segel Irvin H. (2010). Biochemical Calculations. 2nd edition, John Wiley and Sons, New York.
3	Garrett, R. H. and Grisham, C. M. (2009) Biochemistry. 4th Edition, Brooks / Cole, Publishing Company, California.
4	Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (2006) Outlines of Biochemistry 5th edition, John Wiley and Sons, New Delhi.
5	Palmer Trevor (2008). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry 2nd Edition, Horwood Pub. Co., Chinchester, England.
6	White David (2006). Physiology and Biochemistry of Prokaryotes. 3rd Edition. Oxford University Press, New York.
7	David A. Hall & Krishna Rao (1999). Photosynthesis (Studies in Biology) 6th edition, Cambridge University Press, London
8	Harvey Lodish et. al (2016), Molecular Cell Biology 8th Edition W. H. Freeman Macmillan Worth Pub. Co., New Delhi.

	MIC-353 - Large Scale Bioprocesses **Major** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe different types of commercially important fermentation products.	1
CO2	Explain how antibiotics, vitamins, enzymes, amino acids, organic acids are manufactured at industrial scale with the help of microorganisms.	2
CO3	Apply detailed knowledge of the transformation of steroids into pharmacologically active forms with the help of microorganisms	3
CO4	Analyze various flow sheets or flow charts used for extraction of different types of fermentation products	4
CO5	Synthesize and apply single cell proteins	5
CO6	Evaluate the various methods of immobilization of enzymes and whole cells and change in their activity.	6

MIC-353 - Large Scale Bioprocesses
(Major-Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	Microbial production of organic acid, solvents and beverages Organic acid: Acetic acid. Solvents: Acetone butanol Beverages: Beer and wine. Enzymes: Amylase and esterase. Steroids: Microbial transformation with an example of any one steroid in detail	**15**
II	Microbial production of therapeutic agents Antibiotics: Streptomycin, Cephalosporin. Vaccines: Polio, Tetanus. Amino acids: Lysine, glutamic acid Vitamins: Cyanocobalamin, Riboflavin Immobilized enzymes, methods and applications	**15**

Learning Resources- References

Sr. No.	References
1	Casida, L. E., 1984, Industrial Microbiology, Wiley Easterbs, New Delhi
2	Peppler, H. L 1979, Microbial Technology, Vol I and II, Academic Press.
3	Stanbury, P. F. and Whittaker, A. (1984) Principles of Fermentation technology, Pergamon press
4	Prescott. S.C and Dunn, C. G., 1983 Industrial Microbiology, Reed G. AVI tech books.
5	A.H. Patel. (1985), Industrial Microbiology, Macmillan India Ltd.
6	Indian Pharmacopeia and British Pharmacopeia (Latest Edn).

	MIC-354 - Recombination & Gene Manipulation **Elective** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall the key concepts and terminology related to genetic recombination, recombinant DNA technology, and basic molecular biology techniques.	**1**
CO2	Explain the mechanisms of homologous recombination and genetic complementation, including the roles of specific proteins and their functions in recombination processes.	**2**
CO3	Apply knowledge of recombinant DNA technology to generate recombinant DNA molecules and use vectors for gene manipulation in a laboratory setting.	**3**
CO4	Analyze the molecular mechanisms of genetic recombination and recombinant DNA techniques, focusing on the interaction of enzymes, vectors, and hosts.	**4**
CO5	Evaluate the effectiveness of various molecular biology techniques such as PCR, DNA sequencing, and cloning, in achieving accurate genetic analysis and manipulation.	**5**
CO6	Design experimental procedures to create and screen recombinant DNA, utilizing molecular techniques like cloning, PCR, and sequencing.	**6**

MIC-354 - Recombination & Gene Manipulation
(Elective-Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Genetic Recombination**: Concept of Recombination Proteins involved in recombination: RecA, B, C, D, Ruv A, B, C Models for homologous recombination: The Holliday model, Double strand break repair model, Homologous and site-specific recombination Genetic Complementation: Cis-Trans test of genetic function, Intercistronic (rII locus of phage), Intracistronic (β galactosidase)	**15**
II	**Basics of rDNA technology:** Guidelines for gene manipulation Generation of recombinant DNA - Enzymes required for cutting and joining the DNA molecules: Restriction endonucleases and DNA ligase Vectors: Plasmids, cosmids, phagemids Methods to transfer recombinant DNA into host, screening of rDNA, Concept of genomic and cDNA libraries, Concept of clone and probe Basic techniques in molecular biology - Isolation & purification of genomic DNA. Isolation of RNA, Agarose Gel Electrophoresis, Blotting: Northern, Southern and Western, Concept of PCR, DNA sequencing - Maxam Gilbert and Sangers sequencing	**15**

Learning Resources- References

Sr. No.	References
1	Strickberger, M. W., 1985 Genetics, 3rd Edition Macmillan Pub. Co., NY.
2	Stanier, R. Y., 1985, General MIC-robiology, 4th Edition, and 5th edition, MacMillan Pub. Co., NY.
3	Hayes, William, 1984, The Genetics of Bacterial and their Viruses, CBS Pub., New Delhi.
4	Peter J. Russell, iGenetics: A Molecular Approach, 3rd edition, Pearson.
5	Lewin Benjamin, 1994, Genes II, VII and VIII, Oxford University Press.
6	Primrose, S. B. and Old. Principles of Gene Manipulation.
7	Dale, J. W., Schantz, M. V., Plant, N., 2012, From Genes to Genomes: Concepts and Applications of DNA technology, 3rd edition, Wiley-Blackwell Pub., UK.
8	Brown T. A., 2010, Gene Cloning and DNA Analysis, 6th edition, Wiley-Blackwell Pub., UK.

	MIC-355 - Cellular Communication in Bacteria **Elective** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Recall and define key terms related to bacterial secretion systems, quorum sensing, and signaling molecules. Identify and define the major types of bacterial secretion systems, membrane vesicles, and quorum-sensing molecules like autoinducing peptides and acyl homoserine lactones.	1
CO2	Explain the mechanisms and significance of secretion across the cytoplasmic membrane and the differences in secretion systems between Gram-positive and Gram-negative bacteria.	2
CO3	Apply their knowledge of bacterial quorum sensing systems to describe how bacteria use signaling molecules to regulate behavior and virulence.	3
CO4	Analyze the differences in quorum sensing mechanisms between Gram-positive and Gram-negative bacteria, particularly in their virulence systems.	4
CO5	Evaluate the impact of bacterial secretion systems and quorum sensing on bacterial survival, biofilm formation, and virulence factor production.	5
CO6	Design a hypothetical experiment to investigate the role of quorum sensing in bacterial communication and its influence on pathogenicity.	6

MIC-355 - Cellular Communication in Bacteria
(Elective-Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	Cellular communication involving secretion systems in bacteria a. Importance of secretion systems in bacteria b. Membrane vesicles in bacteria c. Overview of secretion across cytoplasmic membrane d. Secretion system in Gram-positive bacteria e. Secretion system in Gram-negative bacteria	**15**
II	Quorum sensing a. Bacterial pheromones b. Quorum sensing in Gram-positive bacteria: The *Streptococcus pneumoniae* ComD/ComE Competence System, The *Staphylococcus aureus* AgrC/AgrA Virulence System c. Quorum sensing in Gram-negative bacteria: The *Vibrio fischeri* LuxI/LuxR Bioluminescence System, The *Pseudomonas aeruginosa* LasI/LasR-RhlI/RhlR Virulence System d. Signaling molecules: Autoinducing peptides, acyl homoserine lactones e. Importance of quorum sensing: biofilm formation, production of virulence factors, conjugation, competence, bioluminescence etc.	**15**

Learning Resources- References

Sr. No.	References
1	Miller MB, Bassler BL. Quorum sensing in bacteria. Annu Rev MIC-robiol. 2001;55:165-99. doi: 10.1146/annurev.MIC-ro.55.1.165. PMID: 11544353.
2	Gera, Charu, and S. Srivastava. "Quorum-Sensing: The Phenomenon of MIC-robial Communication." Current Science, vol. 90, no. 5, 2006, pp. 666–76. JSTOR,
3	http://www.jstor.org/stable/24089114. Accessed 21 Jan. 2025.
4	Green ER, Mecsas J. Bacterial Secretion Systems: An Overview. Microbiol Spectr. 2016 Feb;4(1): 10.1128/MIC-robiolspec.VMBF-0012-2015. doi: 10.1128/microbiolspec.VMBF-0012- 2015. PMID: 26999395; PMCID: PMC4804464.

	MIC-356 - Antimicrobial Therapy and Prevention **Elective** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Define MIC-, MBC and LD50, Describe desirable properties of chemotherapeutic agents	1
CO2	Explain different targets in bacteria and mode of action of different antimicrobial compounds, differentiate between types of antimicrobial compounds	2
CO3	Classify drugs based on the site of action, Interpret mode of action of antifungal and antiviral drugs	3
CO4	Explain mode of action of antimicrobial compounds, distinguish between antifungal and antiviral drugs	4
CO5	Compare different types of vaccines, review different types of antisera	5
CO6	Analyze and assess the immunization schedules in developed and developing countries	6

MIC-356 - Antimicrobial Therapy and Prevention
(Elective-Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Chemotherapy I** Introduction to chemotherapy: Desirable parameters of chemotherapeutic agent (Selective toxicity, Bioavailability of Drug, LD-50 value, routes of drug administration, MIC-, MBC) Drug targets in bacteria with examples of established drugs: Cell wall biosynthesis: Cycloserine, Bacitracin, Carbapenems. Cell membrane functions: Polymyxin B, Monensin, Protein synthesis: Streptomycin, Tetracycline, Nucleic acid synthesis: Nalidixic acid, Rifampicin, Enzyme inhibitors: Trimethoprim, Sulfa drugs.	**15**
II	**Chemotherapy II** **Mode of action of antimicrobial agents on:** **Fungi:** Griseofulvin, Nystatin, Anidulafungin, Voriconazole **Viruses:** Acyclovir, Zidovudine, Oseltamivir **Protozoa:** Metronidazole, Mepacrine **Resistance to antibiotics:** Genetic basis of resistance Biochemical mechanisms of resistance, Development of antibiotic resistance (e.g., VRE, MRSA), Antibiotic misuse **Vaccines and antisera, Developing vaccines.** Immunization schedules: principles, schedules in developing and developedcountries	**15**

Learning Resources- References

Sr. No.	References
1	Chakraborty, P., 2003. A textbook of Microbiology, 2nd Edition New Central Book Agency, India.
2	David Greenwood, 2007. Antimicrobial Chemotherapy, 5th Edition, Oxford University Press.
3	Franklin, T.J and Snow, G. A. 2012. Biochemistry of Antimicrobial Action. Springer Science & Business Media
4	R.S. Satoskar, S.D. Bhandarkar, 2007. Pharmacology and pharmacotherapeutics, PopularPrakashan, 20th edition.

	MIC-357 - Food and Dairy Microbiology **Elective** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Describe the spoilage mechanisms in foods and thus identify methods to control deterioration and spoilage.	1
CO2	Articulate the basis of food safety regulations and discuss the rationale for the use of standard methods and procedures for the microbiological analysis of food.	2
CO3	Apply knowledge of microbiological methods for their isolation, detection and identification of microorganisms in food and employ in industries.	3
CO4	Categorize important pathogens and spoilage microorganisms in foods.	4
CO5	Justify the ways to control microorganisms in foods and thus know the principles involving various methods of food preservation.	5
CO6	Write the significance and activities of microorganisms in food and role of intrinsic and extrinsic factors on growth and survival of microorganisms in foods.	6

MIC-357 - Food and Dairy Microbiology
(Elective-Theory)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**Food Microbiology:** Introduction, Food as a substrate for microorganisms, importance, classification of foods based on stability. **Food Spoilage** –Chemical and physical properties of food affecting microbial growth, Sources of food spoilage causing microorganisms, Spoilage of Meat and Poultry products, Bread, Fruits and Vegetables, Eggs, Sea foods and Canned foods. **Food preservation –** Principles of food preservation, Thermal destruction of bacteria - use of low temperature and high temperature. Determination of TDP, TDT, D, F, and Z values, Use of chemicals and antibiotics, radiations, additives in preservation of food. **Food borne infections and intoxications –** Food borne disease, Laboratory testing - preventing measures **Applications of genetically modified foods**	**15**
II	**Dairy Microbiology:** **Dairy Development in India:** History, Role of National Dairy Development Board (NDDB), National Dairy Research Institute (NDRI), Military dairy farm, Indian Dairy Corporation (IDC), Dairy Co- operatives, Milk Grid, Operation Flood. **Milk Chemistry and Constituents:** Definition and Composition of milk, Types of Milk (skimmed, toned and homogenized), Concept of clean milk, Factors affecting quality and quantity of milk, Physico-Chemical properties of milk. **Microbiology of milk: -** Common microorganisms found in milk, Fermentation and spoilage of milk, Milk borne diseases. **Methods of**	**15**

	Pasteurization: Principle of Pasteurization - LTH, HTST, UHT **Food sanitation and regulation:** Plant sanitation, Employee's health standards, quality control and HACCP	

Learning Resources- References

Sr. No.	References
1	Banwart G. J. (1989). Basic Food MIC-robiology, 2nd Edn. Chapman and Hall, International Thompson Publishing.
2	Clarence Henry Eckles, Willes Barnes Combs, Harold Macy (1943). Milk and milk products, 4th Ed. McGraw-Hill Book Company, Incorporated.
3	James M. Jay, Martin J. Loessner, David A. Golden (2005). Modern Food Microbiology, 7th Edn. Springer Science & Business.
4	Sukumar De (2001). Outlines of Dairy Technology. 1st Ed. Oxford University Press, Delhi.
5	William C. Frazier, Dennis C. Westhoff, N. M. Vanitha (2013). Food Microbiology, 5th Edn. McGraw-Hill Education, India

	MIC-361 - Microbiology Practical-8 **Major** **Practical**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Define and compare different types of hematological indices by using different parameters	1
CO2	Articulate the working, handling and storage of blood in blood banks	2
CO3	Classify different clinical specimens and to interpret the data obtained using different parameters	3
CO4	Organize the data obtained from different hematological tests and predict the clinical condition of the patient	4
CO5	Determine the potential blood donors and recipients by categorizing different types of blood groups and blood cells	5
CO6	Combine and arrange the haematogical data obtained and prepare the hemogram	6

MIC-361 - Microbiology Practical-8
(Major- Practical)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**a)** Estimation of hemoglobin (Cyan-methemoglobin method) **b)** Counting of RBCs and WBCs using counting chambers **c)** ESR, PCV determination **d)** Calculation of hematological indices **e)** White blood cell differential count from peripheral blood **f)** Blood group typing for ABO and Rh systems	**5**
II	**a)** Cross-matching **b)** Widal test **c)** Coomb's test **d)** Immunoprecipitation: Doublediffusion (Ouchterlony) technique **e)** Demonstrations of RPR test and ELISA (Antigen / Antibody detection **f)** Visit blood bank and preparation of visit report	**5**

Learning Resources- References

Sr. No.	References
1	Cruickshank K.R.,2005, Medical MIC-robiology Vol I & II Livingstone, Longman
2	Mukherjee K.L. Medical Laboratory Technology – A practical Manual for routine diagnostic tests – Volume I to Volume III. Tata MacGraw Hill Education

	MIC-362 - Microbiology Practical–9 **Major** **Practical**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Identify the presence of DNA in a sample using basic molecular biology techniques	1
CO2	Explain the methodology for isolation of bacteriophages in laboratory	2
CO3	Carry out the isolation of genomic DNA	3
CO4	Analyse the purity of the isolated DNA using spectrophotometry	4
CO5	Determine the competence of bacterial culture necessary for transformation	5
CO6	Generate transformants and specify recombinants using popular screening methods	6

MIC-362 - Microbiology Practical–9
(Major- Practical)

Unit No.	Title of Unit and Contents	No. of Lectures
I	**a)** Isolation of *E coli* as a host and enrichment of bacteriophage. **b)** Isolation of bacteriophage using *E coli* as bacterial host. **c)** Enumeration of bacteriophages using agar overlay method. **d)** Isolation of genomic DNA by Marmur's method. **e)** Detection and quantitation of DNA using Diphenylamine method. **f)** UV spectroscopy to determine purity of DNA	**5**
II	**a)** Studying the uptake of simple sugars across membranes **b)** Isolation of biofilm producing bacteria from natural habitat **c)** Biofilm formation/ bioluminescence by bacterial isolates **d)** Determining cell viability using redox dye indicator Resazurin **e)** Study tour to a research institute and preparation of visit report	**5**

Learning Resources- References

Sr. No.	References
1	Shende RK, Hirpurkar SD, Sannat C, Rawat N, Pandey V. Isolation and characterization of bacteriophages with lytic activity against common bacterial pathogens. Vet World. 2017;10(8):973-978. doi:10.14202/vetworld.2017.973-978
2	J. Marmur, A procedure for the isolation of deoxyribonucleic acid from micro- organisms, Journal of Molecular Biology, Volume 3, Issue 2, 1961, Pages 208-IN1, ISSN 0022-2836.
3	Burton, K. 1956. A study of the conditions and mechanism of the diphenylamine reaction for the colorimetric estimation of deoxyribonucleic acid. Biochem. J. 62: 315.
4	Dash H.R., Shrivastava P., Das S. (2020) Quantification of DNA by Using UV–Visible Spectrophotometer. In: Principles and Practices of DNA Analysis: A Laboratory Manual for Forensic DNA Typing. Springer Protocols Handbooks. Humana, New York, NY
5	Sambrook, J., & Russell, D. W. (2001). Molecular cloning: A laboratory manual. Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press

	MIC-382 - Microbiology Practical-10 **VSC** **Practical**	
	Number of Credits: 02 **No. of Hours:60**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	State the name of the microorganism used in synthesis of nanoparticles and synthesize *metal nanoparticles.*	1
CO2	Estimate and grade microbial quality of food and dairy products and name the methods used in testing of microbial quality food items.	2
CO3	Carry out isolation and identification of spoilage causing organism from food	3
CO4	Detect adulterants in food products.	4
CO5	Test and perform enrichment, Isolation, Preparation and Application of Bioinoculants at laboratory scale.	5
CO6	Prepare fermented food in the laboratory.	6

Unit. No.	Title of Unit and Content	No. of **Practicals**
I	**Microbial Testing of Food and Dairy Products** **a)** Phosphatase test. **b)** MBRT test. **c)** Test for detection of Mastitis. **d)** Standard Plate Count (for milk / milk product / food products e.g. milk powder, confectionary products) **e)** Direct Microscopic Count. **f)** Detection of Adulterants in food products.	**5**
II	**a)** Isolation and identification of common microorganisms from spoiled food. **b)** Enrichment, Isolation, Preparation and Application of Bioinoculants (e.g. *Azotobacter-Rhizobium/* Blue Green Algae (Cyanobacteria), Phosphate Solubilizer - any one). **c)** Preparation of fermented food (Sauerkraut or Curd- any one). **d)** Laboratory scale fermentation of Ethanol. **e)** Product recovery by distillation. **f)** Estimation using Cerric Ammonium Nitrate method and yield calculation	**5**

Sr. No.	**References**
1	Practical Food Microbiology 3rd edi, edited by Diane Roberts and Melody Greenwood, Blackwelll Publishing, 2003.
2	Kalyanaraman Rajagopal and Venkatachalam Deepa Parvathi (2017) A Practical Manual on Synthesis of Nanoparticles and its Applications in Biology. ISBN:978- 93- 84962-03-2.
3	Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. FSSAI: Manual of Simple methods for testing of common adulteration in food. https://archive.fssai.gov.in/dam/jcr:04ddea72-d3a8-4e4e-809e196d8834b4a8/Manual_Testing_Method_Food_Safety_On_Wheels_30_08_ 2017.pdf

	MIC- 371 - Basics of Mycology and Virology **Minor** **Theory**	
	Number of Credits: 02 **No. of Hours:30**	
Course Outcomes (COs) **On completion of the course, the students will be able to:**		**Bloom's cognitive level**
CO1	Identify and explain the general features, classification, and life cycles of selected fungi	**1**
CO2	Analyze the structure and growth of fungal cells, including hyphae, motile and nonmotile cells, spores, and the factors affecting fungal growth.	**2**
CO3	Evaluate the role of fungi in ecosystems, including their functions as saprophytes, parasites, and in symbiotic associations with plants and animals, and their potential in bioremediation.	**3**
CO4	Develop an understanding of viral properties, structure, classification (ICTV), and cultivation techniques, comparing in vitro and in vivo methods.	**4**
CO5	Assess the impact of waterborne and airborne viral infections (e.g., bacteriophages and influenza) on human and environmental health.	**5**
CO6	Design and propose potential applications of virology in public health, focusing on viral vaccines and antivirals, including their types and uses.	**6**

MIC- 371 - Basics of Mycology and Virology
(Minor-Theory)

Unit No.	Title of Unit and Contents	No. of hours
I	**Mycology**: **a. An Introduction to Fungi** General features of fungi, Classification of fungi, Life cycles of selected fungi (*Aspergillus, Penicillium* and Yeasts). **B. Structure of fungal cells and growth** Hyphae and nonmotile unicells, motile cells, spores, dormancy, growth of population and colonies, effect of environment on growth, prevention of fungal growth **c. Fungi and ecosystem** Fungi as saprophytes, parasitism, mutualism, symbiotic association with plants and animals, attack on fungi by other microorganisms. Fungi and bioremediation.	**15**
II	**Virology:** a. Discovery of viruses, nature and definition of viruses, general properties b. Structure of Viruses c. ICTV classification d. Cultivation and propagation of viruses – *in vitro* and *in vivo* e. Water born viral infection - Eg Bacteriophages f. Air borne viral infections - Eg Influenza	**15**

	g. Plant viruses - structure, life cycle- Example h. Applications of Virology – viral vaccines and antivirals (concept and types)	

Sr. No.	References
1	Fundamentals of Mycology, J.H. Burnett, Publisher: Edward,Arnold Crane Russak.
2	The fungi, M. Charlile and S.C.Watkinson,Publisher: Academic Press.
3	Fundamentals of the fungi. E. Moore- Landeekeer, Publisher: Prentice Hall.
4	Alexopoulos, C.J. and C.W. Mims 1979.Introduction to Mycology (3rd Ed.). Wiley Eastern Ltd., New Delhi.
5	Introduction to Modern Virology. (2001). 5th ed. Dimmock et al., Blackwell Sci.Publ
6	Principles of Virology: (2000). by S.J. Flint et al., ASM Press.
7	Basic Virology, (1999). By Wagner and Hewelett, Black Well Science Publ.
8	Ding SC. Virology: Principles and Applications. Yale J Biol Med. 2008 Sep;81(3):155–6. Epub 2008
9	Teri Shors. Understanding Viruses.Jones & Bartlett Learning, LLC, 2016.

	MIC-395 – On Job Training (OJT) **Major** **Theory/Practical**	
	Number of Credits: 04 **No. of Hours: 120**	